# Person Identification from Biological Motion: Viewpoint Dependencies

Cord Westhoff, Nikolaus F. Troje

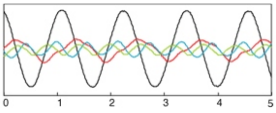
cord.westhoff @ruhr-uni-bochum.de troje@psyc.queensu.ca
www.bml.psy.ruhr-uni-bochum.de

## Introduction

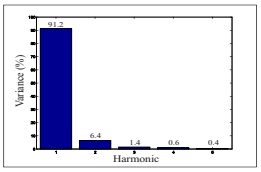
Regarding complex 3D-objects, observers show a decreasing recognition performance with an increasing difference between the learning viewpoint and the test view, but little is known about viewpoint generalization of animate objects. We investigated this problem using biological motion. Observers learned to identify seven unknown male walkers, which were shown as point-light displays, from one of three possible viewpoints: frontal, half-profile, or profile view. In a following session, the same walkers had to be identified from all three viewing angles Therefore, the first question of this study can be formulated as:

**Is there a viewpoint effect between learning view and test view in the identification of point-light walkers ?**

A walking pattern can be described very accurately using Fourier analysis. This results in an average posture and the first few harmonics, resembling the dynamic components of the walk (Troje, 2002). In the database used in this study, the first harmonic covers on average about 91% of the overall variance of an individual`s walk, the second harmonic another 6%. Therefore, one might hypothesize that only the first harmonic is relevant for person identification. Thus, our second goal was to find an answer to the question:




**Scores of the first four principal components over walk cycles (x-axis)** *From: Troje (2002)*



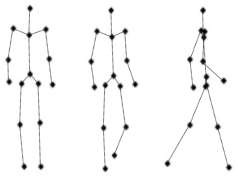

**Amount of variance in a gait pattern explained by the harmonics**

**Is there a proportional relation between the amount of variance a harmonic explains and its importance for person identification?**

## Methods

**Participants:**
18 Observers (9 females, 9 males), subdivided into three groups of equal size, according to the viewing angle of the displays.

**Stimuli:**
**Training stimuli** were Fourier-represented point-light walkers decomposed into an average posture and the first five harmonics, previously normalized with respect to their shape and gait frequency. For each subject, seven walkers were chosen randomly from a database and shown from either a frontal view (FV), half-profile view (HV°) or profile view (PV). For the creation of the **test stimuli** we first computed an average walker and then replaced either only its first (H1), second (H2), or third to fifth harmonics (H3-5) with the respective harmonics of the individual



**FV** **HV** **PV**
(Lines not present in actual displays)

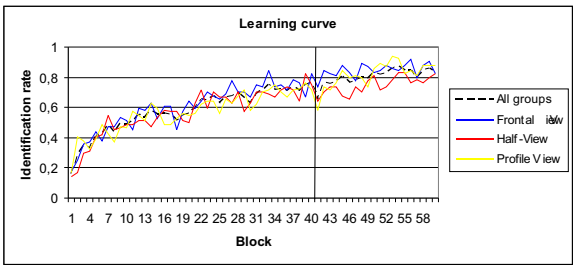
**Design and procedure:**
Displays were shown for 3s, and subjects answered by clicking on one of seven buttons with the names of the walkers. On the first day, four training sessions (140 reinforced trials each) were conducted with the original walker representations, followed by a non-reinforced test session A. Viewing angle remained constant throughout these sessions. On the second day observers were re-trained in two more training sessions. In the final test session B (168 trials) we additionally varied the viewing angle of the displays to examine the generalization performance from the learning view to the other two viewing angles.

**Day 1**
4 Training Sessions
Test Session A
*(Constant viewpoint)*

**Day 2**
2 Training Sessions
Test Session B
*(Varying viewpoints)*

## Results

### Training sessions



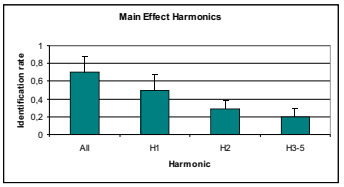

**The vertical line indicates the end of the first training day and the conduction of Test session A**

- ◊ **Groups quickly improved their performances**
- ◊ **Significant improvement between the end of the first and the second day in the Frontal- and the Profile-view groups**
- ◊ **No overall differences between the groups**

### Test session A

**Factors:**
- **Harmonics (4 levels: All, H1, H2, H3-5)**
- **Training Viewpoint (3 levels: FV, HV, PV)**

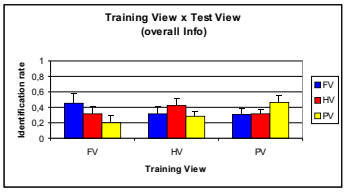
- ◊ **Significant differences between every condition (all *p*s < .02)**
- ◊ **ALL-condition not different from training performance**
- ◊ **H1 and H2 above chance level (*p*s < .001)**




- ◊ **No effect of Training Viewpoint or interaction between Harmonic and Training Viewpoint**

### Test session B

**Factors:**
- **Harmonic (4 levels: All, H1, H2, H3-5)**
- **Training Viewpoint (3 levels: FV, HV, PV)**
- **Test Viewpoint (3 levels: FV, HV, PV)**




- ◊ **Highly significant interaction between training and test viewpoint (*p* < .001)**
- ◊ **Best performance when training view is same as test view**

- ◊ **Main effect of Harmonics replicated (*p* < .001)**
- ◊ **No effect of Training Viewpoint**
- ◊ **Marginal effect of Test Viewpoint (*p* < .05)**

## Discussion

- → Observers are able to learn to identify previously unknown walkers from point-light displays
- → No advantage for a specific training viewpoint was found
- → The first and the second harmonics are important for the identification of a point-light walker
- → The best performance occurs if the test stimuli are shown from the same perspective as in the training
- → There is some generalization to new viewpoints as well

**This work was funded by the Volkswagen-Foundation**